

FROM RESEARCH TO INDUSTRY



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Development of a new tool called **FALSTAFF** to study the fission process

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G. Lehaut, T. Materna, J. Pancin, S. Panebianco,
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GANIL, Caen, France
LPC, Caen, France

**Fission ExperimentS and
Theoretical Advances**

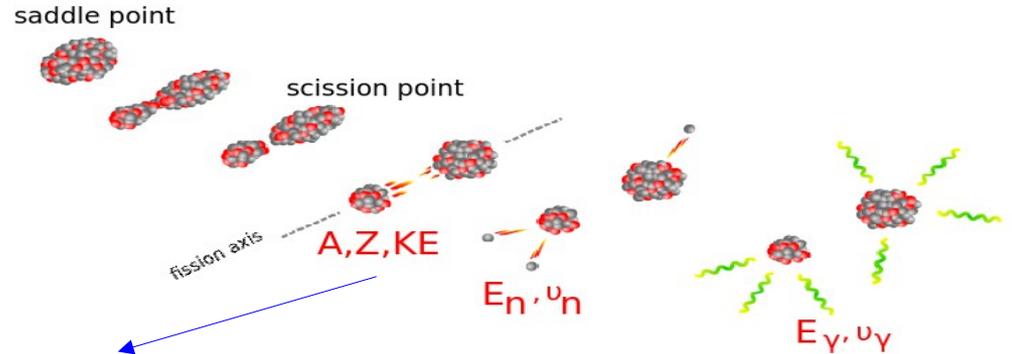
**Sep. 8-12, 2014
Santa Fe, NM, US**

Motivations

Models have been developed to understand and predict the **fission** process
→ needs of experimental **data** to **constrain** the models

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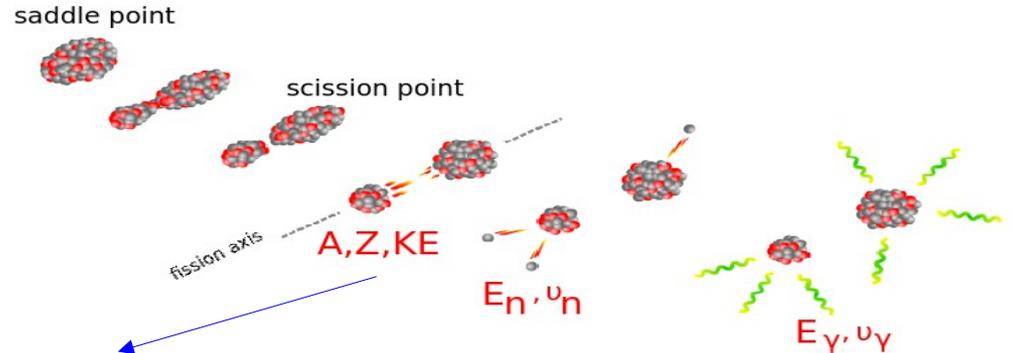
Experimentally, **some observables** are accessible



Excitation energy sharing, shell effects, mass and charge splitting, deformation of fragments...

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Former experiments

In the 50s and 60s (**Thermal energies**)

Fraser & Milton (U-233)

Whetstone et al. (Cf-252)

Apalin et al. (U-235, U-233, Pu-239)

In the 80s & 90s (**Th, ~0,5, 5,5 MeV**)

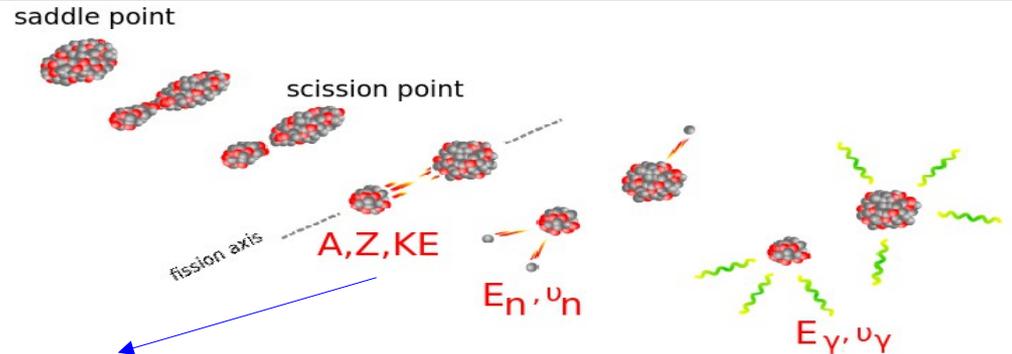
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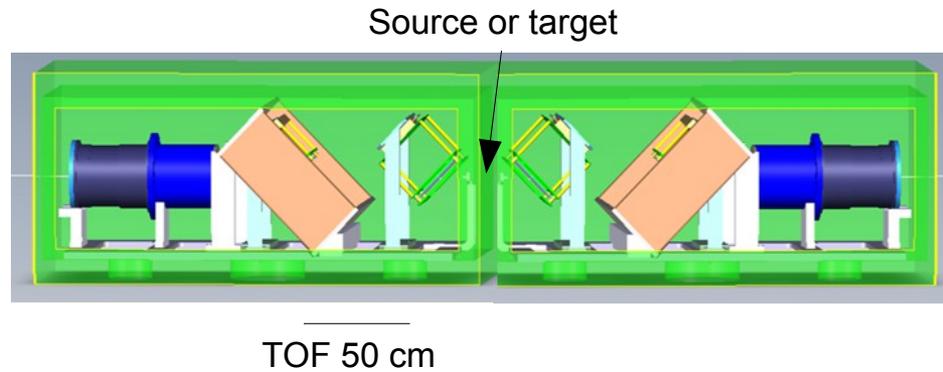
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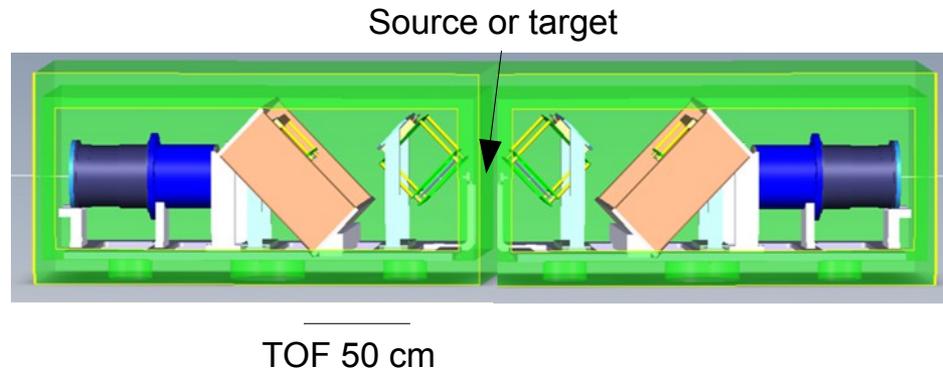
➔ Needs of data

- to obtain a clear view of the evolution with energy
- to enlarge the variety of actinides
- to improve models :
 - understanding of the process
 - production of database for applications

Four Arm cLover for the Study of Actinide Fission Fragments



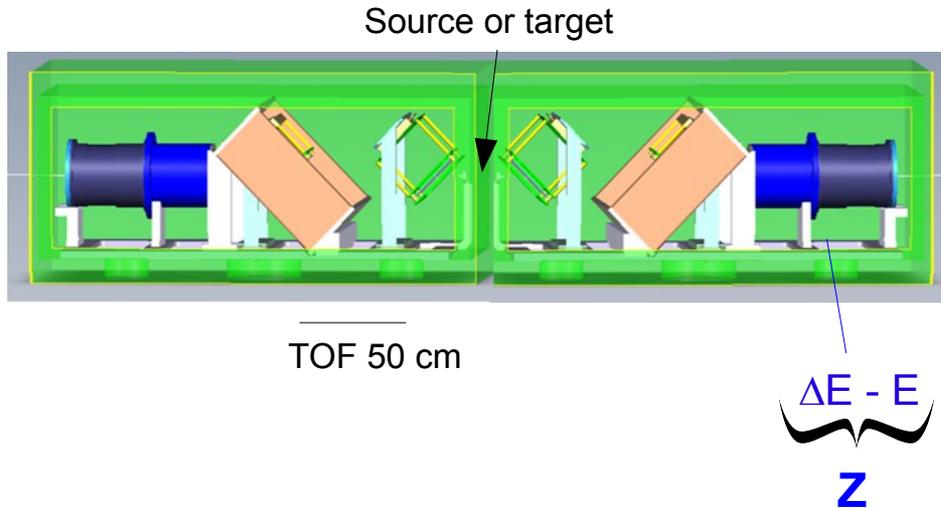
Four Arm cLover for the Study of Actinide Fission Fragments



Fission Fragments in coincidence

- Nuclear charge
 - Kinetic energy
 - Pre-mass (before n evaporation)
 - Post-mass (after n evaporation)
- } Neutron multiplicity

Four Arm cLover for the Study of Actinide Fission Fragments



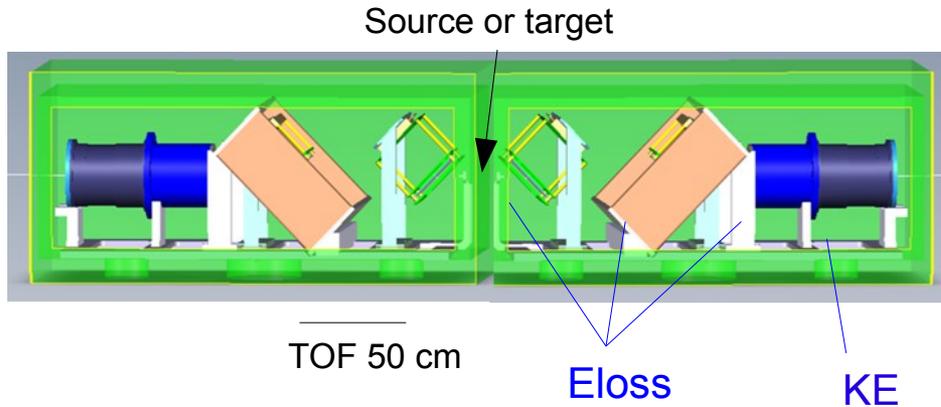
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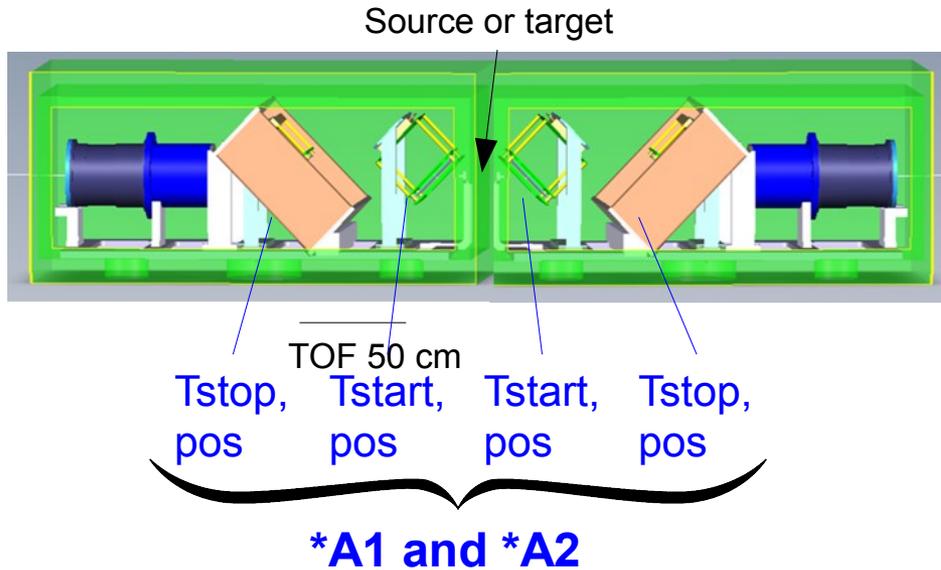
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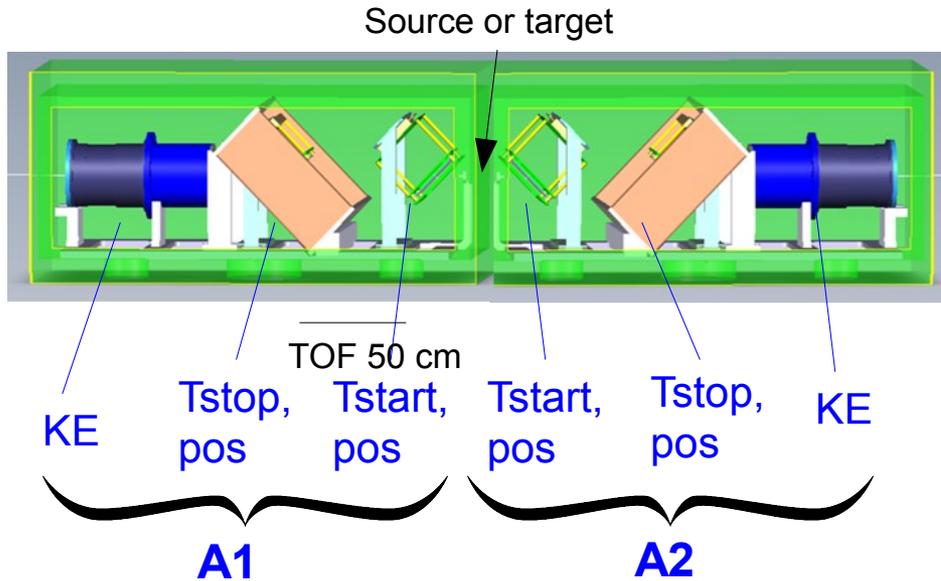
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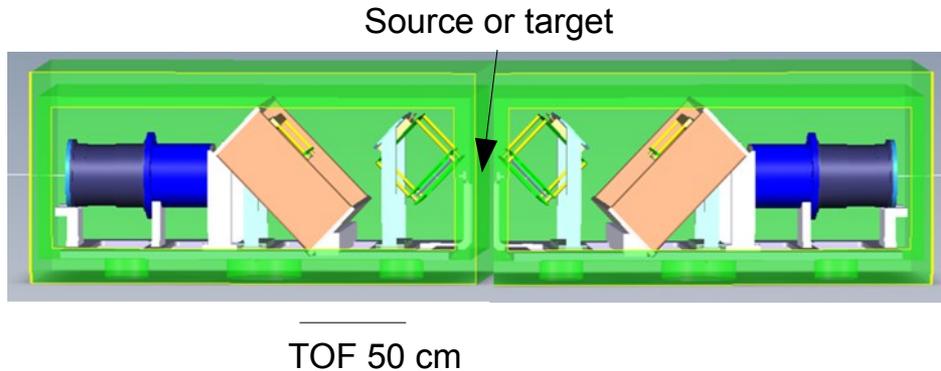
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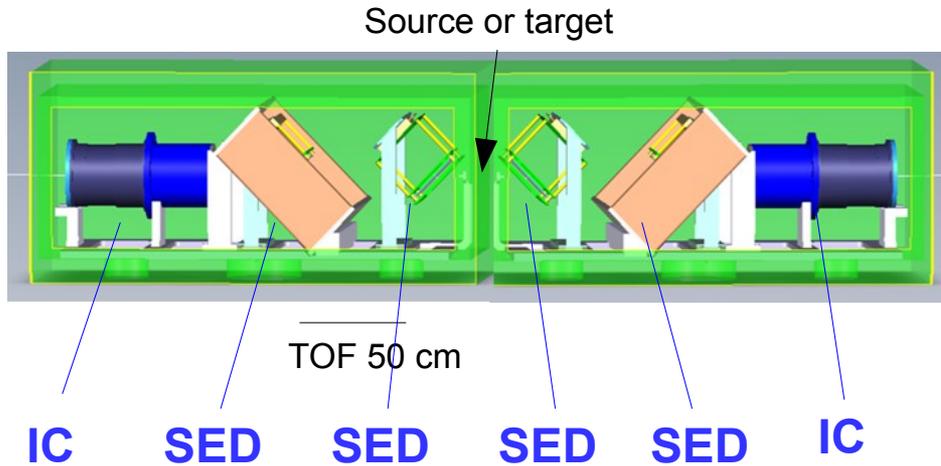
Resolutions :

Energy : 1%
Time : 150 ps
Position : 1,5 mm

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Resolutions :

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Detectors :

- Ionization chamber
- SED / MWPC

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GEANT4 SIMULATION

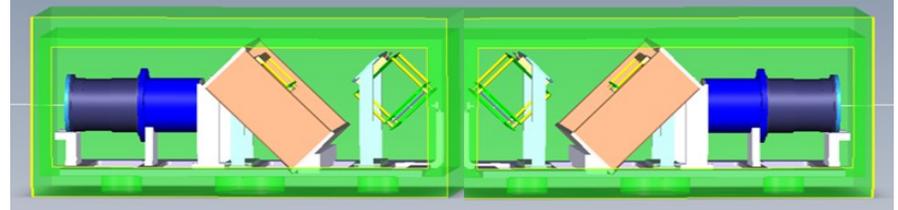
> Simulation:

- Physics events from GEF: $^{252}\text{Cf(sf)}$
 - Full two-arms geometry
- Precise material budget (energy losses, stragglings)

> Multistep analysis :

- Z known
- Corrections for energy loss
- Mass reconstruction from simulated v and E

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SETUP Simulation

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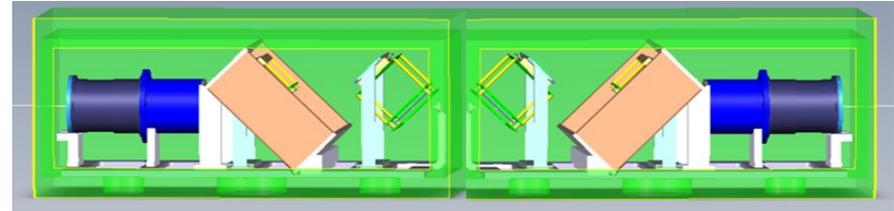
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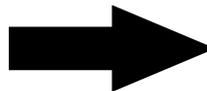


Event-by-event analysis

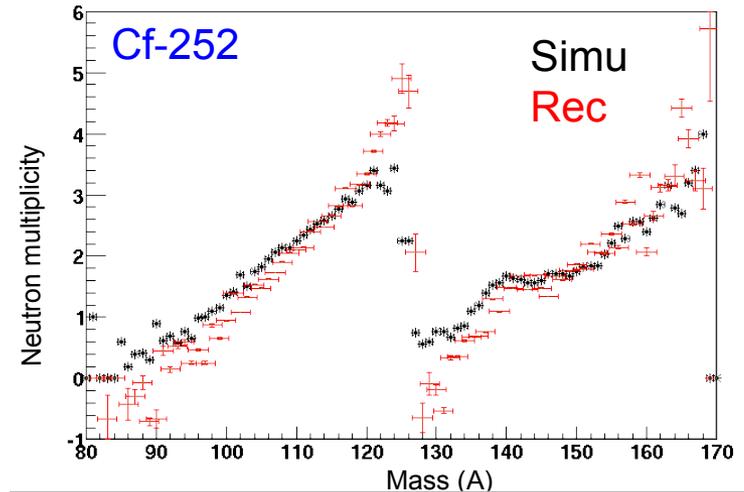
$$\rightarrow M_i - M_f$$

$\langle M_i - M_f \rangle$ vs M_i

$$\Delta(M_i - M_f) = \frac{\langle M_i - M_f \rangle}{\sqrt{N}}$$



Graph



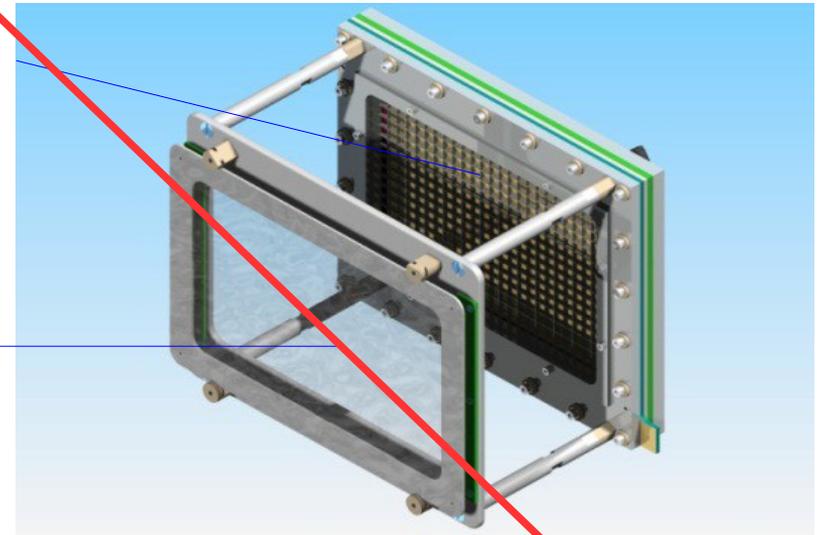
Proposed experimental setup able to provide good quality information

SED detectors

- time measurement
- position measurement
- large solid angle
- low material budget

Electron detector

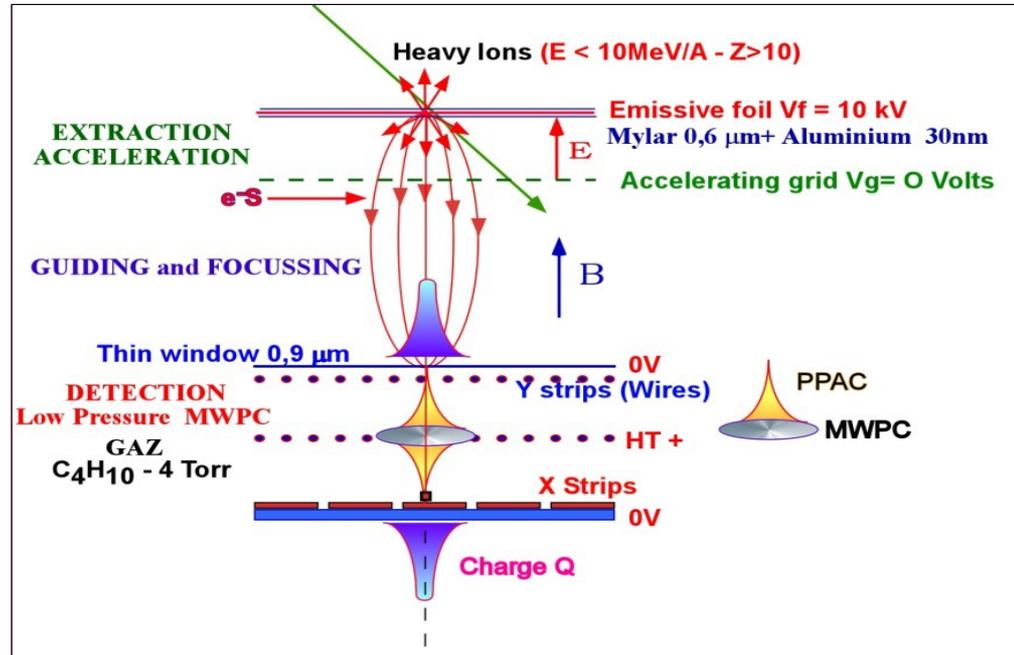
Thin foil



Fission
fragment

SED detectors

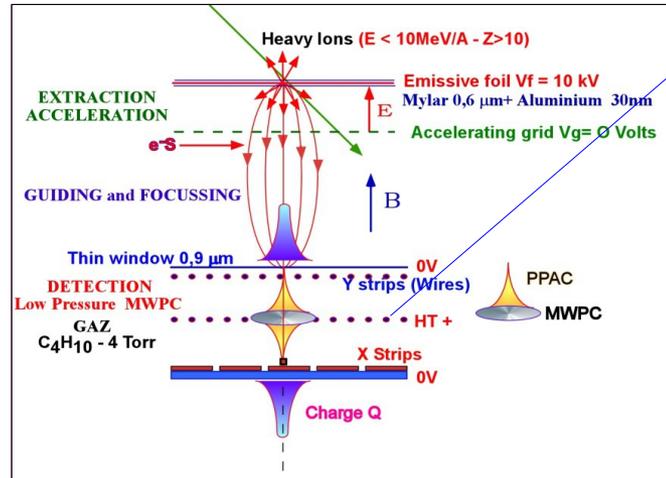
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SED - MWPC

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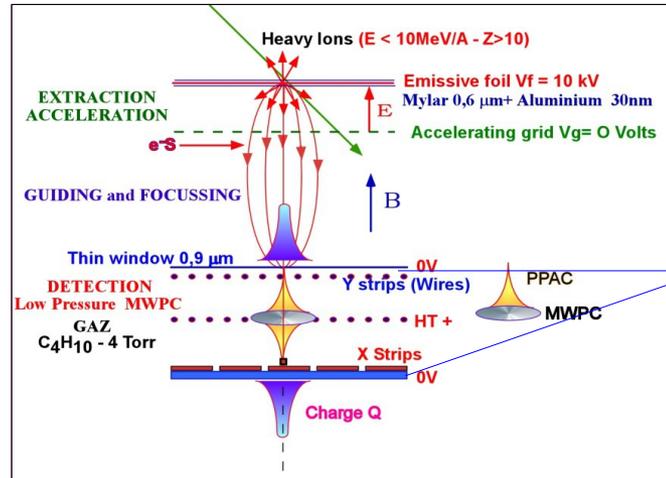


Time information :

- 1 Anode signal
- HF Sampling with MATAcq (VME)

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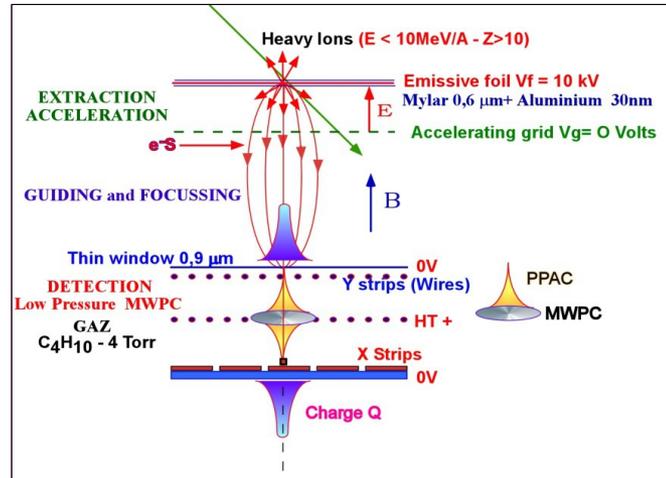
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Position information :

- **SED1** : 24 signals on 1D pixelized cathode + 26 signals on wires
- **SED2** : 48×68 signals on 2D pixelized cathode
- HF Sampling with homemade Asic (AFTER)

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Performances :

Time resolution

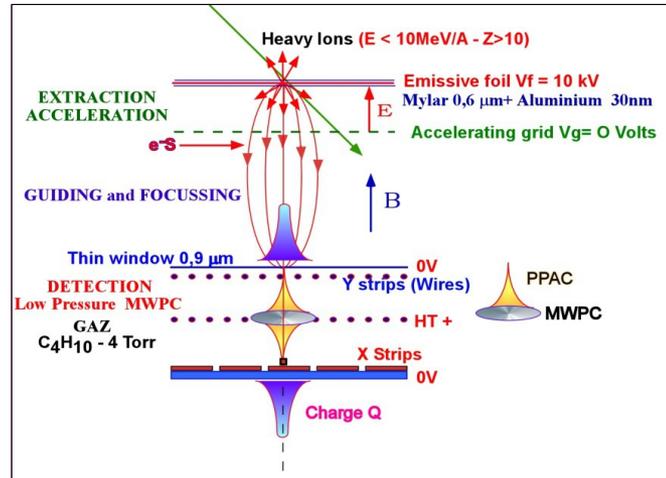
SED 1 : 115 ps

SED 2 : 120 ps

100 ps → with CsI

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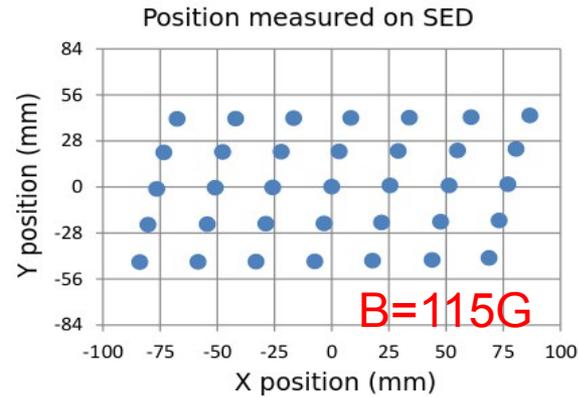
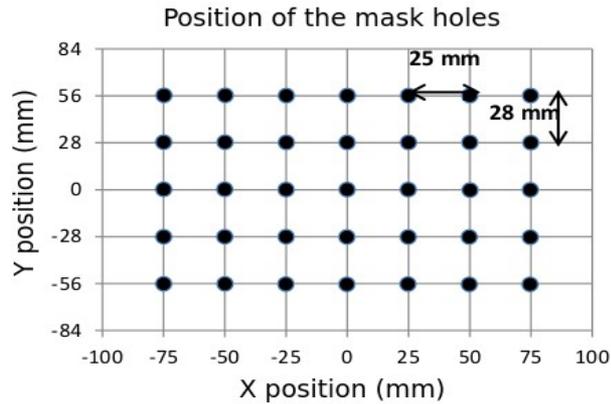
SED 1 : 2 mm, 1,5 mm (B field)

SED 2 : 3 mm, 1 mm (B field)

2 mm, 1 mm (B field) → with CsI

SED : position reconstruction

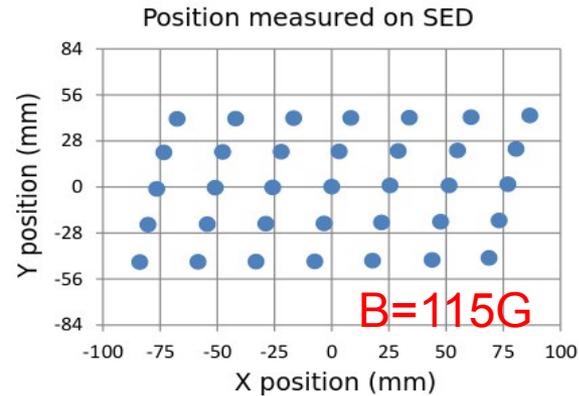
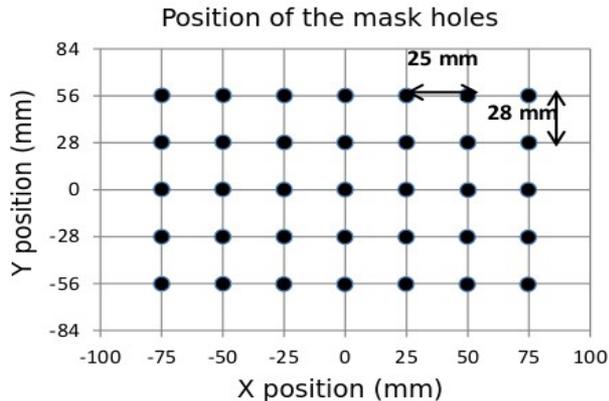
Shift of position due to B field



Shift up to 1.5 cm -> has to be corrected

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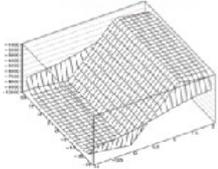
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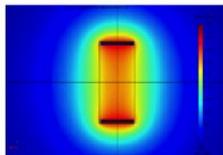
Simulation of SED + magnet

Garfield



Electric field

Comsol

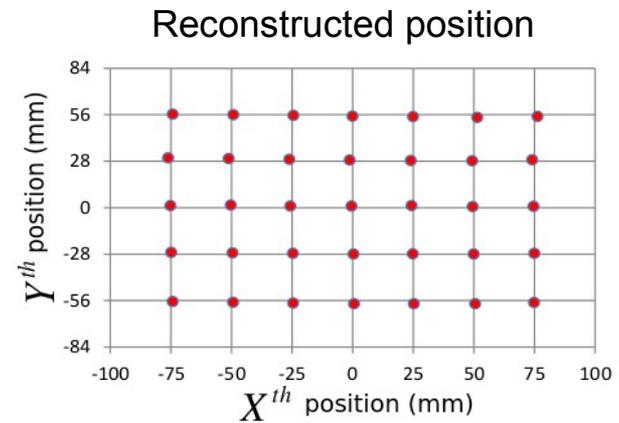


Magnetic field

Geant4

J. Kallunkathariyil

Analytic
method

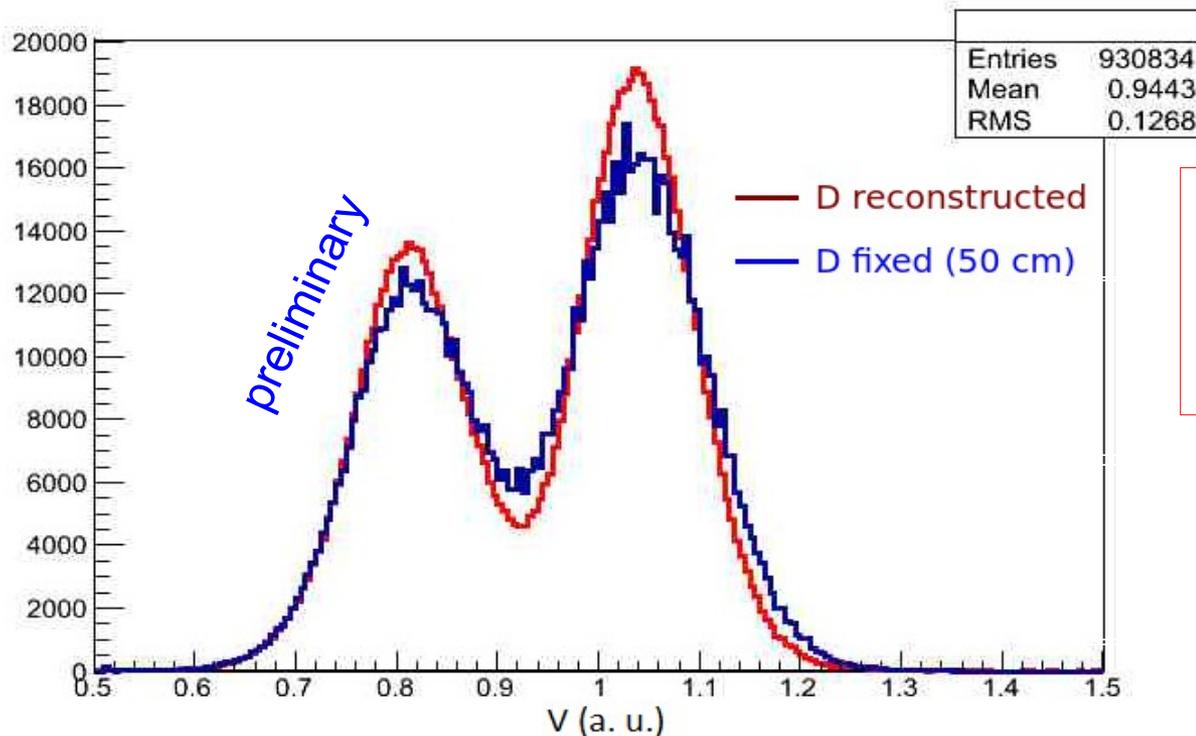


→ Method approved

- DATA acquisition -> 2 different DAQ
 FEMINOS (positions)
 GANIL (time and energy)
- Electronic scheme (dead time, data timing of different detectors...)
 - Analysis program to merge DATA



Velocity spectrum 252Cf source with FALSTAFF



**Validation of the DAQ
 coupling, electronics and
 analysis program**

To be continued....

Conclusions

Needs of complete data for **fundamental** physics and **applications**

→ **FALSTAFF** : (Z,A,Ek) including neutron multiplicities

- SED performances fulfill requirements
- Simulations demonstrate the **feasibility**
- Difficulties in coupling the 2 DAQ systems but **Preliminary experimental data** are promising

Perspectives

- On going construction of an **axial IC** (LPC@CAEN)
- Full characterization with **252Cf**
- Experiments at **NFS, Gelina, nELBE** with actinide targets

PhD begins next week !

THANK YOU !